PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#13

In re the Application of

THOMAS A. GENISE

Application No: 08/666,164 Group Art Unit:

Filed: June 19, 1996 Examiner:

For: AUTOMATED TRANSMISSION SYSTEM CONTROL WITH ZERO ENGINE FLYWHEEL TORQUE DETERMINATION

AFFIDAVIT OF JAMES ROLAND MCREYNOLDS

I, James R. McReynolds do hereby state:

1. I reside at 8660 Merrimac Street, Richland Michigan 49083.

2. My educational background includes a B.A. degree from Roosevelt University in Chicago, and a BFT degree from Thunderbird School of International Management in Phoenix, Arizona.

3. Since June of 1979, I have worked for Eaton Corporation. Initially, I worked as the Transmission World-Wide Product Manager for Eaton Corporation. In 1990 I became the head of Transmission Product and Strategic Planning for North America for Eaton Corporation.

4. In early 1993, I begin developing a concept for a transmission system which would be easier to drive than a manual transmission system, but which would be considerably less expensive than an automatic transmission system.

5. In developing the transmission system I realized

that considerable expense is necessary to eliminate the shift lever of a transmission system. I conceived of a partially automated transmission system which maintains the shift lever, thereby reducing cost, but which provides the driver with clutchless and throttles shifts. I also envisioned the automating splitter shifts in the system so that the driver would have less total number of shift decisions.

6. On August 11, 1993, I sent a specification describing the operation of the partially automated transmission system to Eaton's patent attorney, Howard Gordon. Attached as Exhibit A is a copy of a memo I sent to Howard Gordon on August 11, 1993, and the attached specification. Exhibit A describes clutchless and throttleless shifting with a shift lever in response to an operator depressing a shift switch located on the shift knob. The August 11, 1993 memo indicates that I am going to ask CORDC to simulate the product on the driving simulator so that I can demonstrate the driving concept at a product planning meeting at TCONA.

7. In August 1993, I called Tom Genise to discuss the possibility of developing the partially automated transmission system which I named "AutoStick".

8. I explained to Genise that I would like Eaton Corp. to develop a transmission system which provides the driver with many of the conveniences of a fully automated transmission such as clutchless and throttleless shifts, but which is not much more expensive that a manual transmission system because the shift lever

is maintained.

9. Specifically, I explained to Genise that the "AutoStick" transmission would include a shift lever, a shift button which the driver would depress in order to upshift or downshift. In response to depressing the button, the system would automatically defuel the engine to minimize torque, thereby allowing the driver to move the shift lever to neutral without using the clutch pedal. After the system senses neutral, the system would thereafter calculate the synchronization speed for the next gear, and control the engine to approach the synchronization speed for the next gear.

10. On September 7, 1993, I sent to Tom Genise the specification I previously sent to Howard Gordon.

I declare under punishment of perjury under the laws of the United States of America that the foregoing is true and accurate.

Aug. 29, 1997
Date

James Roland McReynolds
James Roland McReynolds

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AFFIDAVIT OF STEVE EDELEN

I, Steve Edelen do hereby state:

1. I reside at 293 Lake Shore Drive, Battle Creek, Michigan.

2. I am presently the Manager of Engineers for Automated Transmission Division of the Truck Components Operations - Americas (TCOA) of Eaton Corporation.

3. My educational background includes a B.S. degree in Mathematics, a B.S. degree in Mechanical Engineering and a M.S. degree in Operations Research.

4. I joined CORD-DC in 1978 as an engineer.

5. As the Manager of Engineers for Automated Transmission Division of Eaton Corporation, I am responsible for project planning, staffing, and organization of automated transmission programs.

6. On July 14, 1995, I attended and participated in an Automation Strategic Planning Meeting at Eaton's Marshall Michigan

Proving Grounds. Attached as Exhibit , is an AGENDA for that July 14, 1995 Meeting indicating that I made a presentation regarding SPPD for Automation. During the July 14, 1995 meeting, Tom Genise demonstrated the AutoSplit Concept Vehicle.

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7. Prior to the July 14, 1995 demonstration, I became knowledgeable about the AutoSplit transmission system based on technical presentations and reports provided by Tom Genise and/or Ron Markyvech, and based on technical discussions with Tom Genise and Ron Markyvech. I also became familiar with the software structure that was implemented in the transmission ECU based on information presented by Tom Genise and/or Ron Markyvech.

8. During the July 14, 1995 presentation in Marshall, Michigan, I drove a truck that included the AutoSplit transmission system. Based on the demonstration, my experience in automated transmission systems, and my knowledge of the AutoSplit transmission system including the implemented software, the truck that I drove included an engine having an output shaft, a ten speed transmission with a transmission output shaft, an engine ECU for controlling the engine speed and other parameters, a transmission ECU for controlling the engine ECU, a master clutch connected between the engine and the transmission, a clutch pedal for controlling the master clutch, a shift lever for manually moving the transmission into and out of different gear ratios, an intent to shift button on the shift lever for allowing the driver to initiate an upshift or a downshift, and a display for displaying the presently engaged gear, and the next upshift or downshift gear.

9. During my test drive of the truck, the transmission ECU controlled the engine speed to eliminate torque between the engine and the transmission output shaft when I depressed the intent to shift button. Specifically, based upon my depressing of the intent to shift button, the software within the transmission ECU operated to predict or approximate a zero flywheel torque value, and then controlled the engine speed to achieve the zero flywheel torque value. Once this zero flywheel torque value was obtained, I could easily move the shift lever from the engaged gear position to the neutral position.

10. Based upon receiving the intent to shift button, and after determining that I shifted the transmission to neutral, the software within the transmission ECU then modified the engine speed to achieve a synchronization speed determined by the ECU to be necessary for the next shifted gear, that is, upshifted or downshifted gear. My understanding of the software was that the transmission ECU worked similar to the Eaton Top 2 which modifies the engine speed so as to dither about the determined synchronization speed which corresponds to the actual synchronization speed plus or minus an offset value. During my test drive, I performed both upshifts and downshifts.

11. The AutoSplit transmission system performed well during the demonstration including my test drive, by performing the shift sequence as described above, and was well received by the participants at the Meeting.

SE 8/28/97

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on this 28 day of August, 1996,

~~Steven Edelson~~

STEPHEN A EDELSON SC

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

THOMAS A. GENISE

Application No: 08/666,164 Group Art Unit:

Filed: June 19, 1996 Examiner:

For: AUTOMATED TRANSMISSION SYSTEM CONTROL WITH ZERO ENGINE FLYWHEEL TORQUE DETERMINATION

AFFIDAVIT OF JOHN DRESDEN, III

I, John Dresden, III do hereby state:

1. I reside at 21406 Jacksonville Road, Farmington, Hills, Michigan 48336.

2. I have worked in the trucking industry as a truck mechanic and a mechanical technician for over twenty years.

3. Since 1980, I have worked for Eaton Corporation Research and Development Division as a mechanical technician.

4. As a mechanical technician, my responsibilities include building transmissions, assembling prototypes from stock transmissions, building and installing electrical and mechanical

transmission components, such as hoses, sensors, brackets, ECUs, and testing transmissions including recording and obtaining data. I also tested prototype transmission systems by actually driving trucks with the prototype transmissions.

5. From May, 1994 to January 1995, I worked on a transmission project referred to as "AutoSplit". My responsibilities on the AutoSplit project included building the AutoSplit transmission system, installing the transmission system into a Freightliner truck, and testing the transmission system. I also assembled the shift lever for the Freightliner truck which included a button for initiating a downshift or an upshift.

6. In August of 1994, a prototype of the AutoSplit transmission system was completed and implemented in a ten speed Freightliner truck. This AutoSplit prototype was successfully tested during a three day extensive road trip between August 29-31, 1994. The three day trip originated from Southfield, Michigan and included stops at Marshall, Michigan and Traverse, Michigan. The test driving team included Tom Genise, Ron Markyvech, and myself. Attached as Exhibit is a copy of my Travel and Business Expense Report for the August 29-31, 1994 road trip. At the top right hand corner of the Expense Report, there is an indication that the expenses occurred from August 29 to August 31, 1994.

7. The AutoSplit transmission system prototype that was

successfully tested between August 29-31, 1994, was implemented in a Freightliner truck which included an engine, an engine output shaft, an engine ECU for controlling the engine speed and other engine parameters, a transmission ECU for controlling the engine ECU through a SAE J-1939 communication data link, a ten-speed transmission, a master clutch connected between the engine and the transmission, and a clutch pedal for controlling the master clutch. The Freightliner truck also included transmission input and output shaft speed sensors, a manual stick shift for allowing the driver to manually shift the transmission between the ten different speed ratios, a display panel mounted on the shift lever for displaying the presently engaged gear and the next gear, and an intent-to-shift control for sending a signal to the transmission ECU indicating whether an upshift or a downshift is to be initiated. The intent-to-shift switch initiated the upshift or the downshift by signalling to the transmission ECU a desire to eliminate torque between the engine output shaft and the transmission output shaft.

8. The hardware elements of the AutoSplit prototype tested between August 29-31, 1994 have since been re-configured for use in other transmission systems. However, Exhibits 5-11 are photocopies that I took of the actual hardware elements used during the August 29-31, 1994 trip. Specifically, Exhibit 5 is a photocopy of the actual ten-speed transmission used in the test. Exhibit 6 is a photocopy of the actual transmission ECU, Exhibit 7 is a photocopy of the actual engine and engine ECU, Exhibit 8 is a

photocopy of the actual electrical wiring harness, Exhibit 9 is a photocopy of the actual display panel which was mounted on the shift lever, Exhibit 10 is a photocopy of the actual master clutch foot pedal, and Exhibit 11 is a photocopy of the actual truck used during the August 29-31, 1994 trip.

9. During the road test trip of August 29-31, 1994, Ron Markyvech connected his laptop Personal Computer (PC) to the communication data link of the AutoSplit system. This allowed his PC to display such parameters as the predicted torque percentage for achieving zero flywheel torque. During the road trip, while I was driving Ron would command the system to obtain a particular torque value, and then ask me to shift into neutral. The purpose of this test was to determine how easy it was for me to shift into neutral based on the torque parameter he commanded.

10. During the August 29-31, 1994 road trip, the AutoSplit transmission system was extensively tested by monitoring data on Ron Markyvech's PC. In particular, the testing included monitoring the torque values after the intent-to-shift switch was recognized by the transmission ECU; identifying when the transmission was shifted into neutral; monitoring the various engine control parameters in different modes of operation ; and monitoring the transmission input shaft speed. The testing also included monitoring data at the time the transmission shifted into gear as well as evaluating the "feel" of the shift for purposes of

determining shift quality. During the road test trip of August 29-31, 1994, the AutoSplit performed well during these tests.

11. It was my understanding that the AutoSplit transmission prototype described above was subsequently demonstrated to engineers of Eaton's TCONA Division on January 11, 1995. Prior to that demonstration I re-configured the shift lever used during the August 29-31, 1994 road trip. Specifically, I manufactured a shift lever which included an intent to shift button. Exhibit 16 is a photocopy of the this shift lever. In the system tested during the August 29-31, 1994 trip, Ron Markyvech connected his computer to the transmission ECU and used the keys of the computer's keypad as the intent to shift button. As seen in Exhibit 19, this shift lever does not contain a display as did the shift lever used during the road test of August 29-31. Rather, I assembled a separate display which was mounted on the console of the truck. Exhibit 15 is a photocopy of the actual display I assembled.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on this 28th day of August, 1996.

John Dresden, III

PATENT APPLICATION

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THOMAS A. GENISE

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AFFIDAVIT OF WARREN R. DEDOW

I, Warren R. Dedow do hereby state:

1. I reside at 6176 Glenwood Circle, Portage, Michigan 49024-3171.

2. My educational background includes a Bachelor of Science degree in Electrical Engineering (B.S.E.E) from Western Michigan University.

3. Since 1985, I have worked for Eaton Corporation Truck Components Operations Northern America as a Product Engineer.

4. As a Product Engineer at Eaton Corporation, my responsibilities include writing and testing software on automated transmission programs that involve microprocessor based systems. I have experience with C languages on Intel based microprocessors to automate manual transmission designs for the trucking industry.

5. On January 11, 1995, I attended a demonstration of the AutoSplit transmission system presented by Tom Genise and Ron Markyvech. The demonstration was conducted at Eaton's proving

grounds in Marshall, Michigan.

6. Prior to the January 11, 1995 demonstration, I became knowledgeable about the AutoSplit transmission system based on technical presentations and reports provided by Tom Genise and/or Ron Markyvech. I also had several technical discussions with Tom Genise and Ron Markyvech regarding the structure and operation of the AutoSplit transmission system. Further, I became familiar with the software that was implemented in the transmission ECU based on presentations by, and discussions with, Tom Genise and Ron Markyvech, as well as studying the software code.

7. During the January 11, 1995 presentation in Marshall, Michigan, I drove the Freightliner ten speed truck that included the AutoSplit transmission system. Based on the demonstration, my ten year experience in automated transmission systems, and my knowledge of the AutoSplit transmission system including the implemented software, the Freightliner truck that I drove included an engine having an output shaft, a ten speed transmission with a transmission output shaft, an engine ECU for controlling the engine speed and other parameters, a transmission ECU for controlling the engine ECU, a master clutch connected between the engine and the transmission, a clutch pedal for controlling the master clutch, a shift lever for manually moving the transmission into and out of different gear ratios, an intent to shift button on the shift lever for allowing the driver to initiate an upshift or a downshift, and a display for displaying the presently engaged gear, and the next upshift or downshift gear.

An upshift could be initated by the operator if the intent to shift button was depressed while the display device displayed an upshift. Similarly, a downshift could initiated by the operator if the intent to shift button was depressed while the display device displayed a downshift.

8. During my test drive of the truck, the transmission ECU controlled the engine speed to eliminate torque between the engine and the transmission when I depressed the intent to shift button. Specifically, based upon my depressing of the intent to shift button, the software within the transmission ECU operated to predict or approximate a zero flywheel torque value, and then controlled the engine speed to achieve the zero torque value. Once this zero torque value was obtained, I could easily move the shift lever from the engaged gear position to the neutral position. Based upon receiving the intent to shift button, and after determining that I shifted the transmission to neutral, the software within the transmission ECU then modified the engine speed to achieve a speed determined by the ECU to be necessary for the next shifted gear, that is, upshifted or downshifted gear. During my test drive, I performed both upshifts and downshifts.

9. The demonstrated AutoSplit system was impressive and worked well during my test drive. In particular, the AutoSplit transmission successfully operated in the torque control mode and in the speed control mode, during various shift sequences.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on this 29 day of August, 1996,

Warren Raymond Dedow

Warren Raymond Dedow

PATENT APPLICATION

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AFFIDAVIT OF JON STEEBY

I, Jon Steeby do hereby state:

1. I am the Engineering Supervisor - Transmission Automation of the Transmission Division of Truck Components Operations of Eaton Corporation.

2. My educational background includes a B.S. in Electrical Engineering and a B.S. in Computer System Engineering from Western Michigan University. I also have a M.S. in Engineering Management from the Catholic University of America.

3. Since 1988, I have worked for Eaton Corporation Truck Components Operations America (TCOA) previously TCO North America (TCONA) as a enginner. Initially I worked as a senior Systems Engineer. Since 1995, I have worked as an Engineer Supervisor.

4. As an Engineer Supervisor at Eaton Corporation, my responsibilities include management of the design and development of automated manual transmission within the Truck Components

Operations.

5. In early 1995 and in the summer 1995, I attended demonstrations of the AutoSplit transmission system presented by Tom Genise and Ron Markyvech. These demonstrations were conducted at Eaton's proving grounds in Marshall, Michigan.

6. Prior to the demonstrations of the AutoSplit transmission sytsem, I became knowledgeable about the AutoSplit transmission system based on technical presentations and reports provided by Tom Genise and/or Ron Markyvech, and based on technical discussions with Tom Genise and Ron Markyvech. I also became familiar with the software structure that was implemented in the transmission ECU based on code presentations by Tom Genise and/or Ron Markyvech.

7. During the early 1995 presentation in Marshall, Michigan, I drove the Freightliner ten speed truck that included the AutoSplit transmission system. Based on the demonstrations, my experience in automated transmission systems, and my knowledge of the AutoSplit transmission system including the implemented software, the Freightliner truck that I drove and observed at the demonstrations included an engine having an output shaft, a ten speed transmission with a transmission output shaft, an engine ECU for controlling the engine speed and other parameters, a transmission ECU for controlling the engine ECU, a master clutch connected between the engine and the transmission, a clutch pedal for controlling the master clutch, a shift lever for manually moving the transmission into and out of different gear ratios, an

intent to shift button on the shift lever for allowing the driver to initiate an upshift or a downshift, and a display for displaying the presently engaged gear, and the next upshift or downshift gear.

8. During my test drive of the truck, the transmission ECU controlled the engine speed to eliminate torque between the engine and the transmission when I depressed the intent to shift button. Specifically, based upon my depressing of the intent to shift button, the software within the transmission ECU operated to predict or approximate a zero flywheel torque value, and then controlled the engine speed to achieve the zero torque value. Once this zero torque value was obtained, I could easily move the shift lever from the engaged gear position to the neutral position. Based upon receiving the intent to shift signal, and after determining that I shifted the transmission to neutral, the software within the transmission ECU then modified the engine speed to achieve a sbustantially synchronous speed determined by the ECU to be necessary for lever shifting to the next or target gear, that is, upshifted or downshifted gear. During my test drive, I performed both upshifts and downshifts.

9. The AutoSplit transmission system performed well during the demonstrations including my test drive. In particular, the AutoSplit transmission successfully operated in the torque control mode and in the speed control mode, during various shift sequences.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on this 29 day of August, 1996,

8/29/97
Date

Jon Steeby
Jon Steeby

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THOMAS A. GENISE

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AFFIDAVIT OF RONALD K. MARKYVECH

I, Ronald K. Markyvech do hereby state:

1. I reside at 23260 West Outer Drive, Allen Park, Michigan 48101-3127.

2. My educational background includes an Associate in Science degree in Electrical/Electronic Technology from Henry Ford Community College, and a B.E.T degree in Electrical Engineering from Wayne State University, College of Engineering.

3. Since July of 1976, I have worked for Eaton Corporation. Initially, I worked as an electronic technician and an engineering technologist in the Corporate Research and Development - Detroit Center (CORD-DC) of Eaton Corp. Since 1990 I have worked as a product engineer.

4. As a product engineer, my primary responsibility is to develop real time algorithms and software for the control of automatic and semi-automatic heavy duty mechanical transmissions.

5. In April-May 1994, I began working on a transmission project referred to as "AutoSplit".

6. In May of 1994 I prepared a project report entitled "AUTOSPLIT CONCEPT PROTOTYPE" which included a general description of the AutoSplit transmission, and the work that was planned for the project. Attached as Exhibit 1 is a copy of my May 1994 AutoSplit Project Report.

7. My primary responsibility in connection with the AutoSplit project was software development and testing. I also developed and tested the electrical system needed for communicating between the engine Electronic Control Unit (ECU), the transmission ECU and the various system sensors, including the input and output shaft speed sensors. I was also responsible for testing the J1939 data communication link between the engine and transmission ECUs. In addition, I developed and tested the gear display device and connected my PC laptop computer to the transmission ECU for purposes of sending command signals to the transmission ECU and for receiving and evaluating data from the transmission system.

8. In August of 1994, a prototype of the AutoSplit transmission system was completed and implemented in a ten speed Freightliner truck. This AutoSplit prototype was successfully tested during a three day extensive road trip between August 29-31, 1994. The three day trip originated from Southfield, Michigan and included stops at Marshall, Michigan and Traverse, Michigan. The test driving team included Tom Genise who was the system engineer for the AutoSplit project, John Dresden III who was the

driver/mechanic for the AutoSplit project, and myself. Attached as Exhibit 2 is a copy of my August 1994 Project Report for the AutoSplit project which mentions the August 29-31, 1994 AutoSplit road trip.

9. Per Eaton Corporation's policies and procedures, members of a test driving team can be reimbursed for expenses incurred during a road trip. In order to obtain such reimbursement, each member of the driving team must submit a Travel and Business Expense Report. Attached as Exhibit 3 is a copy of my Travel and Business Expense Report for the August 29-31, 1994 road trip. At the top right hand corner of the Expense Report, there is an indication that the expenses occurred from August 29 to August 31, 1994. Towards the bottom half portion of the Expense Report next to the heading "Purpose of Trip:", there is the notation "Project #5956-01 AutoSplit Concept Transmission Development Road Trip". Project #5956-01 was the project number for the AutoSplit project. In the section explaining the day by day expenditures, there is an indication that I paid for the meals of Tome Genise, John Dresden and myself.

10. The AutoSplit transmission system prototype that was successfully tested between August 29-31, 1994 was implemented in a Freightliner truck which included an engine, an engine output shaft, an engine Electronic Control Unit (ECU) for controlling the engine speed and other engine parameters, a transmission ECU for controlling and communicating with the engine ECU through a SAE J-1939 communication data link, a ten-speed transmission, a master

clutch connected between the engine and the transmission, and a clutch pedal for controlling the master clutch. The Freightliner truck also included transmission input and output shaft speed sensors, a manual stick shift for allowing the driver to manually shift the transmission between different speed ratios, a display panel mounted on the shift lever for displaying the presently engaged gear and the appropriate next gear, and a laptop computer which acted as an operator intent-to-shift control switch or button for sending a signal to the transmission ECU indicating whether a particular shift, i.e., whether an upshift or a downshift is to be initiated as the next gear shift, and for requesting that the engine be fueled to minimize driveline torque allowing easy disengagement of an engaged ratio without requiring disengagement of the master clutch. For example, an upshift was initiated when the operator depressed the intent to shift switch of my laptop computer while an upshift was being displayed on the display, and a downshift was initiated when the operator depressed the intent to shift switch while a downshift was being displayed. The operator intent-to-shift switch initiated the upshift or the downshift by first signalling to the transmission ECU a desire to eliminate or minimize torque between the engine output shaft and the transmission output shaft. Based upon receiving the operator intent to shift signal, the transmission ECU modified the engine fueling to reduce torque to the transmission without disengaging of the master clutch. The operator could then easily shift the transmission to neutral. Based upon receiving the intent to shift

signal, and after sensing that the transmission was shifted to neutral, the transmission ECU then controlled the engine to achieve a determined engine speed necessary for the next gear ratio. Exhibit 4 is a block diagram of the AutoSplit transmission system. While Exhibit 4 is undated, I prepared this block diagram sometime prior to January 1995. The diagram is an accurate representation of the prototype tested between August 29-31, 1994.

11. The hardware elements of the AutoSplit prototype tested between August 29-31, 1994 have since been re-configured for use in other transmission systems. However, Exhibits 5-11 are photocopies of the actual hardware elements used during the August 29-31, 1994 trip. Specifically, Exhibit 5 is a photocopy of the actual ten-speed transmission used in the test. Exhibit 6 is a photocopy of the actual transmission ECU, Exhibit 7 is a photocopy of the actual engine and engine ECU, Exhibit 8 is a photocopy of the actual electrical wiring harness, Exhibit 9 is a photocopy of the actual display panel which was mounted on the shift lever, Exhibit 10 is a photocopy of the actual master clutch foot pedal, and Exhibit 11 is a photocopy of the actual truck used during the August 29-31, 1994 trip.

12. The AutoSplit transmission system tested during the August 29-31, 1994 trip included several software engine control routines. These software routines were implemented in the transmission ECU. Exhibit 12 is a printout of the actual software code contained in the transmission ECU during the August 29-31,

1994 test trip. The front page of Exhibit 12 identifies the dates of the various files contained in the software program, with the latest date being August 29, 1994. With the assistance of Tom Genise, I wrote, tested, modified and debugged the software program of Exhibit 12. The program is written in "C" computer language.

13. As indicated above, the software program of Exhibit 12 includes several software engine control routines. One such routine is able to predict or determine zero flywheel torque based on system variables, and then modify engine speed to achieve the zero torque condition. The zero flywheel torque condition enables the driver to easily move the transmission out of gear engagement and into the neutral position. The software program of Exhibit 12 includes module "drl_cmds.c96" which contains the function "determine_shiftability_variable" and the function "needed_percent_for_zero_flywheel_trq". These functions serve to predict a zero flywheel torque based on system variables. The function "control_intent_to_shift" and the function "intent_final_pct_trq" which are also contained in module drl_cmds.c96 serve to modify engine fueling such that a zero torque condition exists. In particular, the function intent_final_pct_trq serves to ramp the torque down to the zero flywheel torque value. During the road test trip of August 29-31, 1994, I connected my laptop Personal Computer (PC) to the communication data link of the AutoSplit system. This allowed my PC to display the predicted torque percentage for achieving zero flywheel torque. During testing on the road trip, I commanded intent_final_pct_trq to equal

the predicted torque percentage as well as other torque percentages. Once the zero flywheel torque condition existed, the transmission was manually moved out of gear engagement and into a neutral position. The function determine_gear from module trns_act.c96 determined when the transmission moved to the neutral.

The transmission ECU included software routines for determining the currently engaged gear and the next expected gear. Specifically, based on information from the input and output shaft speed sensors, the function determine_gear from module trans_act.C96 determined the currently engaged gear. The function get_automatic_gear from module sel_gear.c96 determined whether an upshift or a downshift is to be expected as the next shift and calculated the speed ratio at the next expected gear. The function get_automatic_gear determined whether an upshift or downshift is to be expected based on such operating conditions as upshift/downshift points, transmission input speed, output shaft speed and acceleration pedal position.

The transmission ECU further included a software routine for determining a synchronization speed for the engine based on the next expected gear ratio and the transmission output speed. Specifically, within module drl.cmds.c96, the function control_engine_sync was used to control the engine synchronization speed. Further, in order to determine the' sync speed for the next gear, the function desired_engine_speed was set equal to (int)(gos_signed + sync-offset), where gos = (next gear x transmission output shaft speed). In order to ensure that the

synchronization speed was obtained and to ensure full clutch tooth engagement, the software controlled the engine speed to vary or toggle above and below the true sync. speed. This ensured that the engine speed would periodically cross the actual sync. speed. Specifically, in the module drl_cmds.c96, the function control_engine_sync and the if statement "toggle" varied the engine speed above and below an offest of the true sync. speed every two seconds. Once the substantially synchronization speed was obtained, the operator could manually shift the transmission towards the next expected gear.

14. During the August 29-31, 1994 road trip, the AutoSplit transmission system described above was extensively tested by monitoring data on my PC. In particular, the testing included monitoring the torque values after the intent-to-shift switch was recognized by the transmission ECU; monitoring when the transmission was shifted into neutral; monitoring and evaluating the various engine control parameters in different modes of operation (including the torque control mode and speed control mode); and monitoring the transmission input shaft speed. The testing also included evaluating data at the time the transmission shifted into gear and considering the "feel" of the shift for purposes of determining shift quality. The road trip of August 29-31, 1994 was a success as the AutoSplit transmission system performed well during testing.

15. During the development of the AutoSplit transmission system, I periodically gave technical presentations to engineers at

the Transmission Division of Eaton's Truck Components Operations North America (TCONA) regarding the development and operation of the AutoSplit transmission system. These presentations often included a detailed discussion of the software code. For example, on September 29, 1994, I went to TCONA in Galesburg, Michigan to give such a presentation. Exhibit 13 is a copy of an Expense Report that I submitted on September 30, 1994. Regarding the "Purpose of Trip", the Expense Report includes the statement: "Project #5956-01 went TCONA for software code walk through and technical presentation on the AutoSplit concept."

16. The AutoSplit transmission prototype described above was subsequently demonstrated to engineers of Eaton's TCONA on January 11, 1995. The demonstration occurred at Eaton's proving grounds in Marshall, Michigan. Tom Genise and I performed the demonstration. The Eaton TCONA engineers that attended the demonstration included John Steeby and Warren Dedow. Attached as Exhibit 14 is a partial printout of my 1995 Personal log. The entry for January 11, 1995, indicates that I went to Marshall, Michigan and demonstrated the AutoSplit transmission system implemented in the Freightliner truck. During the demonstration, John Steeby and Warren Dedow each drove the truck. The AutoSplit transmission prototype performed well during this demonstration.

17. The AutoSplit transmission system demonstrated on January 11, 1995 was basically the same system tested during the road trip of August 29-31, 1994. One difference between the two systems concerned the shift lever. In the system tested between

August 29-31, 1994, the top portion of the shift lever contained a display for displaying the currently engaged gear and the next gear (see Exhibit 9). In the system demonstrated on January 11, 1995, the display was re-configured as a separate device mounted on the truck's console. Exhibit 15 is a photocopy of the actual display used at the January 11, 1995 demonstration. Another difference between the two systems concerned the shift lever. In the system tested during August 29-31, 1994 trip, the shift lever did not contain the driver intent-to-shift switch. Rather, during the August 29-31, 1994 trip, I connected my PC to the system's communication data link and entered the intent-to-shift command by depressing keys on my the keyboard of my PC. In the AutoSplit system demonstrated on January 11, 1995, a new shift lever was implemented which included an intent-to-shift switch or button. Exhibit 16 is a photocopy of the actual shift lever with the intent-to-shift button used during the January 11, 1995 demonstration. The shift knob with the shift button was added on November 10, 1994 as indicated by the entry for this date in my personal log.

18. There was also a modification to the software that was demonstrated on January 11, 1995 as discussed below. Exhibit 18 is a copy of the software code implemented in the transmission ECU that was demonstrated on January 11, 1995. According to this code, function sequence_shift will call function shift_initiate which will set engine_commands to ENGINE_PREDIP which then calls function control_engine_predip to control the engine torque

parameter to zero as a function of predicted zero torque.

19. During the period of time from the beginning of July 1995 through the end of June 1996, I worked as a senior product engineer at Eaton Corporation's Corporate Research & Development Center in Detroit, Michigan (CORD-DC) in the automated transmission development program for heavy duty vehicles. During this time period, the automated transmission program included related projects under the names "AutoShift","AutoSplit" and "Top Two". These projects were all transmission systems utilizing dynamic clutchless shifting wherein mechanical transmissions could be shifted using engine controls without requiring the operator to utilize the clutch and/or throttle pedal. Further, these projects had essentially the same or similar software structure for purposes of automating and/or assisting a clutchless transmission shift sequence. For example, each of these projects included software for automatically controlling the engine fueling to achieve zero flywheel torque for clutchless shifting into neutral from a gear to be disengaged, to sense the engaged ratio and/or neutral condition of the transmission, and to achieve engine synchronization speed for clutchless engaging a target gear ratio.

During the period of time from the beginning of July 1995 through the end of June 1996, I continuously worked on developing products for heavy duty trucks in Eaton's automated transmission program. As indicated in the table below, the majority of my time on a monthly basis between July 1995 and June 1996 was spent on developing products for the AutoShift/AutoSplit/Top-Two automated

transmission projects.

July '95	83.5 hours
Aug. '95	109.5 hours
Sept.'95	133.0 hours
Oct. '95	169.0 hours
Nov. '95	137.0 hours
Dec. '95	83.5 hours
Jan. '96	101.5 hours
Feb. '96	90.0 hours
Mar. '96	121.0 hours
Apr. '96	121.0 hours
May '96	131.5 hours
June '96	81.0 hours
Total	1,361.5 hours

Attached as exhibit 23 are my personal logs for 1995 and for 1996. These logs detail my work activity on a daily basis for 1995 and 1996. Below, I summarize my product development activities relating to the automated transmission projects.

In July 1995, Tom Genise and I worked on the AutoShift and AutoSplit automated transmission projects. Towards the end of July, I worked on learning the transmission manager code for the AutoShift 7-speed transmission project. The July 1995 Monthly Report that I prepared for the AutoShift 7-Speed prototype. This Report also indicates that the software and manager code were

studied during July 1995.

Throughout August 1995, I worked on development of the 7 speed AutoShift project. This work included identifying a problem with the reverse gear switch. Specifically, on August 28, 1995, I found that the reverse gear switch would give a mismatch when trying to engage low gear. I also found an interlock problem that was caused because function "x_outside_offset" was too small.

In September 1995 I worked on the AutoSplit and AutoShift projects. On September 11, 1995, I stripped the AutoSplit wire harness out of a test vehicle for use in a 7 speed AutoShift test vehicle. Much of the remainder of the month was spent installing and testing the vehicle interface wiring. My September 1995 Report for the 7 speed AutoShift details the accomplishments for the month including modification of the base AutoShift software, testing the Freightliner vehicle wire harness, modifying the four rail shift bar housing, installing the transmission in a truck, and starting initial system debugging.

In October 1995, I spent most of my time working on the 7 speed AutoShift vehicle software. My October 1995 Report for the 7 Speed Autoshift details the accomplishments for the month which includes modifying the software to account for the varying step sizes of the seven speed transmission, and adding in software the capability of adjusting the upshift point based on the target

In November 1995, I continued work on the 7 speed Autoshift project. On November 21, 1995, I wrote a miles/hour MI_PER_HOUR reading software routine for the AutoShift, and bench tested the

routine. On November 28, 1995, I tested the AutoShift truck to obtain acceleration data. My November 1995 Report (exhibit) for the Autoshift 7-Speed Prototype indicates the accomplishments for the month as including testing the vehicle, and demonstrating the vehicle on November 11, 1995.In November I also started work on the Top Two project. On November 13, 1995, I went to Galesburg, Michigan to pick up the Top Two truck that will be used for evaluation purposes.

In December 1995, I started working on the performance code for the 10 speed AutoShift. On December 11, 1995, I tested the performance code for the 10 speed AutoShift. On December 21, 1995, I tested the 10 speed Autoshift in different performance modes of operation. My December 1995 Report indicates that the accomplishments for the month included installing and testing various software code for allowing the engine to upshift at higher engine RPMs, for adding an additional 400 RPMs to the deceleration rate of the engine during upshifts, for allowing double upshifts, and for using the engine compressing brake when doing skip shifting.

Much of January 1996 was spent developing a skip shiftability function for the AutoShift transmission system with Tom Genise. On January 31, 1996, I demonstrated the skip shiftability feature to Marcel Amsallen of Eaton Corporations' Truck Component Operation North Americas (TCONA) in Gallesberg, Michigan. I also attended a meeting on January 11 at TCONA regarding the Top-Two project. My attached January 1996 Report (exhibit) indicates that the skip

shift algorithms were developed, and that an adaptive algorithm that monitors the turn off delay of the engine compression brake used on skip upshifts was incorporated into the software.

In February, I started working on the Top 2 project which was implemented in a Mack truck. I also continued work on the AutoShift project. On February 15, 1996, I worked on getting my laptop computer to run the ENG2 diagnostic software. On February 26, 1996, I worked on AutoShift truck-as-test-stand code. Attached is my February 1996 AutoShift Support Report which indicates that test software was written that allows the AutoShift truck to be used as a stationary test stand. Also attached is my February 1996 Report entitled Top Two Continued Support. The Report indicates that accomplishments for February 1996 included receiving software and hardware packages for testing and evaluation, and implementing engine controller ENG2 diagnostic software on a desk top PC.

Much of March 1996 was spent working on software for the Top Two project. This included work on the select gear module SEL_GEAR on March 14, 15 and 21. Attached are my personal log for 1995 and my personal log for 1996. These personal logs (exhibit 23) indicates that the accomplishments for March included writing and incorporating the SEL_GEAR module. Further, a competitive comparison was prepared for the Mack system versus the AutoShift system. In addition, at the end of March I'worked on the AutoSplit project. Specifically, on March 28-30, I worked on installing a wiring harness for an AutoSplit system in a test vehicle.

In the beginning of April 1996, I continued work on installing

the AutoSplit wiring harness. On April 22, I worked on the torque transducer software/calibration. I also worked on the Mack Top Two towards the end of April. My April 1996 Report entitled MACK TOP TWO CONCEPT PROTOTYPE indicates that during April coding efforts continued. My April 1996 Report entitled Volvo AutoSplit Retrofit indicates that the AutoSplit system was installed in a new Volvo vehicle that was supplied to TCONA, and that repairs were made to the wiring harness during the installation.

Most of May 1996 was spent working on the Mack Top Two. On May 8, 1996, I tested output shaft speed acceleration. On May 14, I worked on debugging the skid detection routine. Towards the end of May, I worked on getting the Mack Top Two to shift automatically on the bench. My May 1996 Report entitled Mack Top Two Concept Prototype indicates that coding efforts continue, and approximately 4.4K bytes of code have now been written. Further, the Report indicates that testing and debugging of the Top Two modules started.

In the beginning of June 1996, I continued working on getting the Mack Top Two to shift automatically on the bench. On June 10, I worked on the resync portion of the Mack Top Two software code. My June 1996 Report entitled "Mack Top Two Concept Prototype" indicates that initial software is not approximately 90 percent complete. During the last two weeks of June, I worked on installing the AutoSplit in a new vehicle for purposes of testing and evaluation. My June 1996 Report entitled AutoSplit Continued Development also discusses the AutoSplit transmission installation.

I declare under punishment of perjury under the laws of the United States of America that the foregoing is true and accurate.

8-28-97
Date

Ronald K. Markyvech
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